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Introduction

This report is intended to be part of the work in Chapter 10 of the PATH Report. In reviewing the background for Chapter 10, we discovered many studies of how land use affects habitat quality and many studies of localized chinook *abundance* as a function of habitat quality. However, we found only a handful of studies that analyze chinook *survival* as a function of habitat quality. Herein we begin to address this issue. It analyzes the degree to which the over-wintering survival of Snake River spring/summer chinook juveniles, which were tagged as parr with Passive Integrated Transponder tags (PIT tags), is associated with land use/vegetation cover and variations in annual subbasin-specific migratory corridor indices and climate indices.

This analysis extends the work of Achord and Sanford (1996) on recovery proportions of over-wintering spring/summer chinook that were tagged as parr in the summer and fall in their natal streams and detected the following spring at Lower Granite Dam (LGR). In that study, the dependent variable was the percentage of fish detected at LGR from each year's releases. They found a significant relationship between recovery proportions and habitat quality ratings, distance from the tagging location to LGR, and the year the fish were tagged. The latter variable is presumably a surrogate for fluctuating environmental conditions (e.g., flows, water temperature). Their analysis is summarized in the October 1996 version of Chapter 10. Jeremy Collie (1996) re-analyzed their data, and found that a model using "subbasin" (Middle Fork Salmon, Oregon streams, etc.) fit the data better than one using the Achord and Sanford habitat ratings.

Our study looks at a similar dataset in more detail. We use the number of detections of individual fish at three mainstem dams as the dependent variable. This is assumed to be a surrogate for survival, under assumptions described below. We developed a set of monthly climatic indices for the stream where the fish were tagged and for their migration route. We also used a variable (habitat cluster) which summarizes land use and vegetation cluster because it has

been found to be a good predictor of subjective habitat quality ratings. The data, methods, and results are described in more detail below.

The results should be viewed as preliminary for several reasons. First, we used only release groups for which PATH participants had ranked the over-wintering habitat. Second, we only used release groups which had complete data on all environmental indices from the month the fish were tagged until the beginning of the spring outmigration the following year. Finally, because some of the independent variables were correlated with one another, it may be difficult to separate their effects on parr-to-smolt recovery proportions.

Data

We began by identifying all releases in the PTAGIS database which were described as spring or summer chinook of wild origin and were tagged above Lower Granite Dam. We then selected the stocks that were tagged in at least five calendar years, and for which PATH habitat ratings were available. Twenty-five “stocks” or release sites fit these criteria (**Table 1**). From these releases, we selected fish tagged as subyearlings (age 0+) between July 1 and November 31. Fish tagged between January 1 and May 31 were almost always recaptured the same calendar year. Since our goal is to relate over-wintering conditions to survival, we felt that the January-May groups were tagged after they had “overwintered” in their subbasin of origin and were therefore excluded. Releases in June and December were sparse and so were also excluded. Release information included of release date, release site, and length at release. Length at release is included as a surrogate for conditions in the fry-to-parr stage prior to capture/release in the subbasin. We assumed that larger fish were more likely to have encountered more favorable conditions, and were more likely to survive from release to recapture at the mainstem dams. The first year of releases was 1988, the last is 1995. Most release sites had 5-10 release groups per year.

Recaptures were retrieved from PTAGIS as the *first* recovery of each fish at a mainstem dam (Lower Granite, Little Goose, and McNary). Data retained from recapture files included recapture date, release date, time, and site, and recapture site. Recapture efficiency was estimated at each dam using daily flow and spill records at that project from the USACE, assuming a 1:1 ratio of water spilled to fish spilled (i.e., the percentage of smolts passing the dam via the spillway is assumed to be equal to the percentage of water spilled). We further assumed that, of fish

routed through the turbines, the proportion detected at PIT tag counters was the same across all years for each detection site.

The mainstem flow measure used for each combination of release group/release year/recovery site was the average flow at Lower Granite (LGR) in the 15 days preceding detection at each dam, for all detected fish from that release site/recovery site and year. We averaged the flow data in this way (i.e. over all detections from a release site each year) so that we could include release groups which had no detections at a given dam. Therefore, for any given release site and year, all fish had the same value of the independent variable flow at each dam, although the values for detections at Little Goose (LGS) and McNary (MCN) may differ from those for LGR due to different (i.e., later) detection dates at the lower dams. Spill (used to calculate spill efficiency) was handled similarly, with average values for each release site/recovery site combination for each year. However, spill proportions were assigned based on spill/flow ratios at each dam on days when fish from each release site were recaptured. In effect, this assumes that all fish released at a given site in a given year faced the same mainstem conditions. Approximately three percent of the candidate release group/release year/recovery site combinations had no mainstem recoveries at one or more dams. These were excluded since we had no information on conditions they faced in the mainstem Snake.

Climate data for each release site included streamflow at the closest USGS gauging station, snowpack at the closest NRCS snowpack gauge, precipitation at the closest NOAA climate recording station, daily Lower Granite flow, and the distance in river kilometers from the release site to Lower Granite Dam. Streamflow records were located at the USGS sites for each state on the World Wide Web (WWW). Snowpack records were downloaded from the NRCS BBS, precipitation was downloaded from the NOAA climatological data WWW site. See **Figure 1** for locations of climate stations and release sites. Flow and spill at Lower Granite, Little Goose, and McNary dams was downloaded from the University of Washington DART WWW site. All daily data except the spill fraction and mainstem Snake flows were converted to monthly mean values. The distance to Lower Granite dam from each release site was calculated from information in the PTAGIS Specification Document (PSMFC 1997). Distances for multiple release sites in the same subbasin were averaged.

Not surprisingly, the climate data showed strong correlations both within a given indicator (e.g., October subbasin flow and November subbasin flow) and between indices (e.g., October precipitation and November streamflow). Therefore, we constructed sets of indices (**Table 2**)

that are intended to summarize conditions from roughly the time the fish are tagged until they began their downstream migration. This leaves a set of six potential independent variables: distance to LGR, length of fish at release, flow at LGR, maximum January-March snowpack, average September-March precipitation, and average September-March subbasin flow. Note that snowpack, precipitation, and subbasin flow are standardized across years for each release site to mean 0, unit variance, to allow comparisons across sites.

We considered two different ways to represent habitat quality of the over-wintering sites. The first was to use subjective habitat quality ratings developed by Idaho and Oregon state fisheries biologists (see the revision to Chapter 10, June, 1997). However, we were concerned that these ratings would not prove to be reproducible because two biologists evaluating the same stream reach might arrive at different conclusions. Instead, we decided to employ a “cluster” variable developed by Danny Lee of the USDA Forest Service. The cluster variable in Table 1 is based on data developed by federal land management agencies for their assessment of land management in the Columbia Basin east of the Cascade mountains (the Eastside Assessment). It is a summary of land use patterns on a 1 KM² grid for over-wintering areas. It summarizes both land ownership and vegetation patterns in a single variable. Five habitat cluster values are represented in our PIT tag release samples: AG, MDRY, TRAN, WILD, and YDRY. The values are defined as follows:

Cluster name	Principal Ownership and Use	Vegetative Composition
AG	Private agriculture	Agriculture, transitional areas
MDRY	USFS high impact, USFS moderate impact, USFS low impact and wilderness	Older dry forest, transitional areas
TRAN	BLM rangeland, private forests, USFS grazing land, USFS moderate impact	Transitional areas, mountain shrub lands, young conifer stands
WILD	USFS low impact and wilderness	Young conifer stands, transitional areas
YDRY	USFS high impact, USFS low impact and wilderness, private forests	Young dry forests

These cluster variables were found to be the best predictor of the habitat ratings done by Oregon and Idaho state fish and wildlife agency personnel for the 36 spring/summer chinook index stocks that spawn in the Eastside Assessment area¹. The clusters apply to over-wintering habitat, as distinct from spawning and early rearing areas.

¹ Details on the methods used to “predict” the habitat ratings should be available in June.

After matching the release sites that had habitat ratings and complete data on subbasin-level climate variables (see below), we had 1106 release groups, where a group is defined as all fish released at a subbasin site (trap, weir, or seine sample) on a particular day. Except for the last 2-3 years if the study, there were no slide gates installed at PIT tag detectors. The gates allow fish detected at upstream dams to bypass the transport barges, and re-enter the river in the tailrace. Therefore, while we can estimate recovery proportions, it is not possible to estimate recapture-type survivals.

Tables 3A and **3B** display univariate statistics for the data used to calculate release and recovery proportions, grouped by cluster. The tables show the considerable variation in the number of releases and in the proportions of fish detected across clusters and recovery sites.

Table 4 shows univariate statistics and correlations among the independent variables for the entire dataset (1106 release groups * 3 recovery sites). **Table 5** contains similar information for each cluster. Although some correlations are fairly high, especially between LGR flow and precipitation, most are modest. Negative correlations between maximum snowpack and subbasin flow measures are fairly common. We suspect that this is because a large snowpack probably does not melt until after our flow measures cease for the season, in March for most flow measures and in April-June for LGR flow (when most fish pass the Snake River dams).

Methods

Table 3B shows that the observed proportion of fish recovered at Lower Granite, Little Goose, and McNary is small, ranging from 0.01-0.15. Expanding these proportions for spill, as described above, leads to estimated recovery proportions of approximately 0.01-0.24, depending on the dam and land use/vegetation cluster. Observed mean recoveries expressed as counts of individual fish also vary substantially, from 1.03 to almost 30. There are many ways one can model the data, depending on the assumption one makes regarding the distribution of the dependent variable. Achord and Sanford appear to have used the untransformed recovery proportions, while Jeremy Collie (Collie, 1996) used an arc-sine transformation of the recovery proportions. Since recoveries from any given release group at a particular dam are zero for about 40-50% of the daily release groups, we decided to treat the recoveries as count data of rare events. We analyze it assuming a Poisson model with scaled variance. Therefore, we estimate models of the following form (Cormack and Skalski, 1992):

$$E(n_{ij}) = \mu_{ij} = R_i \theta_{ij} f_j \quad \text{Eq. 1}$$

Where :

i indexes release groups (i.e., release sites or habitat clusters);

j indexes dams (recovery sites);

n_{ij} is the number of fish in release group i found in the fish detected at dam j ;

$E(n_{ij})$ is the expected number of tagged fish from release group i in expected to be found in the sample inspected from dam j ;

μ_{ij} is the expected number of tag codes from release group i found in the fish detected at dam j ;

R_i is the number of fish released in group i ;

θ_{ij} is the probability that a fish from release group i is detected at dam j ;

f_j is the proportion of smolts at dam j assumed to go through the PIT tag detector.

Equation (1) can be expressed as a log-linear model:

$$\ln(\mu_{ij}) = \ln(R_i f_i) + \ln(\theta_{ij}) \quad \text{Eq. 2}$$

with variance

$$\text{Var}(n_{ij}) = \phi \mu_{ij} \quad \text{Eq. 3}$$

The $\ln(R_i f_i)$ term in Eq. 2 is used as an offset, and the estimated parameter is constrained to equal one in the estimation procedure (SAS[©] PROC GENMOD). The $\ln(\theta_{ij})$ term in Eq. 2 can be partitioned into effects due to release site, climate covariates, habitat quality cluster, etc. These effects are what is of interest in the analysis. In particular, the analysis will try to detect associations between:

1. habitat clusters;
2. subbasin flows, precipitation, or snowpack;
3. flow at LGR;
4. distance to LGR;
5. size at release;

and the number of fish from each release that is detected at the three mainstem dams. This obviously assumes that the detections are distributed as a Poisson, with variances scaled according to Eq. 3. We estimated three broad classes of models:

1. A model which includes release site, detection site, year of release, month of release, length at release, and their interactions with release site. Our intent in estimating **Model 1** was to see how well we could fit the recovery data with a very general model. The model effectively

says that release sites, months, and years are different, but does not try to associate those differences with habitat quality or climate variables.

2. A model which includes habitat cluster, detection site, year of release, month of release, length at release, and their interactions with cluster. Our intent in estimating **Model 2** was to see how well we could fit the recovery data with slightly more specific model than **Model 1**. **Model 2** effectively says that clusters, months, and years are different, but does not try to associate those differences to climate variables.
3. Models that include habitat cluster, detection site, climate covariates, month of release, size at release, and their interactions with habitat cluster. The models (**Model 3** through **Model 5**) ascribe differences in detection to: size at release, month of release, habitat quality (as represented by the clusters), climate indices, and their interactions.

For each of the five models noted, we also estimate an “A” model with all data, and a “B” model that eliminates observations having Anscombe residuals more than 3 standard deviations removed from the mean (typically 1-2 percent of the observations).

All models include interactions between release site or habitat cluster and all other variables except recovery site. The release month is also included in each model. They also include recovery site as an independent variable. Therefore, recoveries are effectively “weighted” by recovery site, which should help to addresses concerns about differences in “detectability” between recovery sites.

Results

We focus our discussion of results on goodness-of-fit measures and analyses of deviance for the different models (1-5). Estimates of coefficients associated with individual variables and interactions are included as an appendix. However, we discuss the habitat cluster parameters in detail, as these are the primary variables of interest. We also devote a modest amount of attention to the climate parameters, because they have interesting features as well.

Goodness-of fit measures for models **1A** and **1B** (using release site, recovery site, year of release, length at release, and release month) and **2A** and **2B** (like 1, but with habitat clusters instead of release site) are shown in **Table 6²**. Models **1A** and **2A** fit the data reasonably well,

² Models 1A and 1B did not converge completely when attempting to calculate their respective ANODEVs, due to the large number of paramters. This suggests that one should be cautious in placing too much weight on their goddness-of-fit results.

explaining roughly 71 and 63 percent of the null deviance, respectively. However, Model **2A** has a substantially lower AIC (Akaike Information Criteria) and BIC (Bayesian Information Criteria) than does Model **1A**, due to the reduction in parameters (62 vs. 169). This suggests that Model **2A** is superior to Model **1A**, when one considers goodness-of-fit measures that account for the “parsimony” of the models.

As noted above, we were concerned that outliers might affect the results. In an attempt to evaluate this, we calculated Anscombe residuals for each model, following McCullagh and Nelder (1989, p. 38), scaled to account for the “ ϕ ” term in Eq. 3. Normality plots for models **2A** and **2B** are shown in Figures **2a** and **2b**, respectively. As can be seen from the figures, the residuals for model **2A** have some marked outliers. Most of these are eliminated when removing observations having Anscombe residuals more than three standard deviations from the mean. As will be seen when we examine analysis of deviance results, the outliers have only modest effects on the results.

Table 7 displays goodness-of-fit measures for Models **3A-4B**. All of the models include habitat clusters, length at release, month of release, recovery site, LGR flow, and one subbasin climate index, as indicated in the table headers. The proportion of deviance explained by the models that include all observations ranges from 0.595 to 0.672, suggesting that the models all fit the data with about the same degree of accuracy. Not surprisingly, models with outliers deleted fit better as measured by the proportion of deviance explained. Because the number of parameters is the same for all models, their AIC and BIC scores tell about the same story, with each model scoring roughly the same. In addition, their AIC and BIC scores are a good deal lower than for Models **2A** and **2B**, due to the reduction in parameters (from 62 to 44). The reduction number of parameters results from analyzing only two environmental covariates (LGR flow and subbasin snow, precipitation, or flow) rather than 8 year effects (1988-95).

Analyses of deviance (ANODEV) for models **2A** and **2B** are shown in **Table 8**. As is apparent from the table, removing outlying observations had no substantial effect on the results, at least in the sense that the significance of the independent variables is unchanged. The ANODEVs for models **3A-5B** are shown in **Table 9**. As with Model 2, removing outliers rarely effects the results. The only exception Model 3. Here, month of release is insignificant when using all observations, and marginally significant (P value of 0.0126) when outliers are deleted. In addition, snowpack is marginally significant with all observations included (P value of 0.0345), and insignificant when outliers are excluded. Habitat cluster and its interactions with the other independent variables are significant in all models where they are included.

We focus our discussion of individual estimated parameters on the habitat clusters and climate variables in Models **3B**, **4B**, and **5B**, as shown in **Table 10**. The models use maximum January-March snowpack, average September-March precipitation, and average September-March subbasin flow, respectively, as the climate indices for each release site or habitat cluster. They also use flow at Lower Granite for all stocks. Both sets of parameters are estimated as main effects and as interactions with the habitat clusters. Note that these models are estimated after removing outliers, as described in the “Methods” section.

Several features regarding the habitat clusters are noteworthy. First, looking only at main effects, “TRAN,” transitional habitat, and “WILD,” wilderness habitat, always have significantly higher numbers of fish recovered than the “YDRY” areas more affected by land management activities. Given the relatively short time (5-10 months) between release of parr and subsequent detection, it suggests that habitat quality, as reflected in the cluster variable, may indeed have an effect on fish survival during the last year of freshwater life, even in models that “control” for climatic conditions, length of mainstem migration, and fish size. We also note that this relationship, at least for the “TRAN” cluster, appears to be independent of the climate variables, as it can also be seen in the detailed results for Model **2B** (see appendix).

One aspect of the climate variable results is especially interesting. In two of the three models in **Table 10**, LGR flow (M_FL_15) is insignificant. The interaction terms in these models (**3B** and **4B**) are always negative and significant, however. In the one model (**5B**) where the main effect is significant and positive, while its interaction terms are always significant and negative. Given the strong positive relationship found between mainstem flow and spawner-recruit survival (e.g. Chapter 4 of the PATH report) this result is quite intriguing.

At least three possible explanations come to mind, assuming that the result is not spurious. The first is related to the way in which recovery numbers are estimated. We assume the proportion of fish spilled equals the proportion of water spilled (the f_i term in Eq. 1). Now, we also know that spill has a high positive correlation with total flow, since turbine capacities are often exceeded at high flows. If the 1:1 ratio of spilled water to spilled fish understates spill efficiency, one might obtain a spurious, negative relationship between LGR flow and fish recovered, since recoveries might be under-estimated at high spills and hence flows. A second is the spawner-recruit flow-survival result occurs not because of effects in the mainstem hydrosystem, but because of delayed effects in the estuarine and marine environment. Note that these delayed effects might be associated either because of fish condition (e.g., higher flows ->

stronger fish), or because of correlations between high flows and better post-hydrosystem conditions. A third possibility is that high flows are associated with high spawner-recruit survivals because they are also associated with better egg-parr survival, rather than better survival in the downstream migration or subsequent life stages.

Discussion and Future Work

The results reported here are preliminary, and as such should viewed with caution. However, the analysis raises some interesting questions for both the habitat group and others in the PATH process. For example, why does mainstem flow seem to be negatively related to the number of fish recovered? How does one explain the apparent relationship between flow and over-wintering survival/recovery proportions, compared with its positive relationship in life-cycle survival? Is it because this portion of the mainstem may not be the one in which the majority of the mortality takes place? See Hinrichsen et. al., "Effects of the ocean and river environments on the survival of Snake River stream-type chinook salmon." and Ch. 4 update on early ocean effects and consider that these effects are wrapped into mainstem survival in CWT-derived SAR estimates. It could, for example, be the case that flow is relatively unimportant for early downstream survival, but that snowpack, subbasin flows, and other over-wintering conditions are closely correlated with both flow and spawner-to-recruit recovery proportions (though this is not apparent in the correlations in tables 4 and 5).

On the habitat side, the transitional type (TRAN) habitat type has consistently higher recoveries than the reference cluster, YDRY. In most models, the same holds for the wilderness areas as well (WILD). It also appears that the importance of the habitat variables is often expressed as a combination of main effects and through their interaction with climate variables. (This is also true for interactions of habitat cluster with distance to Lower Granite and with month of release, though the pattern is less consistent. See the Appendix for more details.) At one level, this is to be expected: we are modeling very complex processes with extremely simple models, using a four-level factor (CLUSTER) to represent all of the variation in habitat condition for over two dozen release sites. At another, it would be more encouraging if the results were more consistent across year-factor and climate indices.

We look forward to comments on both data, methods, and the preliminary results. We have several areas of concern. Some have already been noted above. Others include the following:

- We assume a scaled Poisson distribution for the observed recoveries. Is this the most appropriate model to use?
- The outlier detection/deletion scheme that we have used is only one of many possibilities. Others include Cooke's D, the "hat" matrix, and other residual measures (likelihood, Pearson, deviance, etc.) Would others be more appropriate?
- Given the focus on habitat quality, we did not estimate interactions terms except for release site or cluster and the other independent variables. Would it be appropriate to include additional, possibly higher-order interaction terms?
- Because many (if not most) fish that arrive at LGR and LGS were transported in the years for which we have abundant PIT tag data, we cannot use the arrival numbers (our dependent variable) as direct surrogates for survival. We could conduct a sensitivity analysis using only years in which slide gates were operating at the detectors, in which case we could use capture-recapture style survival estimates as our dependent variable. However, if we do so, we would be limited to at most 3-4 years of release/detection data. Is this advisable?

We look forward to your comments and criticisms.

Table 1. Release Sites, Habitat Cluster Designation, Distance to Lower Granite

REL_SITE	CLUSTER	KM_T_LGR
BEARVC	WILD	619
BIGC	WILD	478
CAPEHC	WILD	629
CATHEC	AG	330
ELKC	WILD	633
FRENCC	TRAN	777
GRANDR	YDRY	416
HERDC	TRAN	696
IMNAHR	TRAN	162
IMNAHW	TRAN	162
IMNTRP	TRAN	162
LAKEC	MDRY	449
LEMHIR	TRAN	570.5
LEMHIW	TRAN	570.5
LOOKGC	YDRY	235
LOSTIR	AG	271
MARSHC	WILD	624.5
MARTRP	WILD	624.5
MINAMR	WILD	245
SALREF	TRAN	682
SALRSF	MDRY	400
SAWTRP	TRAN	747
SFSTRP	MDRY	400
VALEYC	TRAN	739
WENR	YDRY	171

Table 2. Variable Definitions

Variable	Label
AVGFLOW	Avg. flow, Sept.-March
AVGPREC	Avg. Precip., Sept.-March
CLUSTER	habitat cluster name
EXPPROP	Proportion recovered expanded for spill
EXP_1_1	mean 1/1 exp. factor for spill
KM_T_LGR	KM to LGR Dam
LEN_AVGM	Avg. length at release
MAX_SNOW	Max(Jan_swe, Feb_swe, Mar_swe)
M_FL_15	Avg. flow, LGR, 15 days pre-recovery
NFISHTOT	Sum of fish released
OBS_PROP	Observed proportion recovered
OBS_REC	Observed recoveries by dam and release date
REL_EXP1	Expansion factor, $\ln(\text{nfishtot} * \text{exp_1_1})$
REC_SITE	Recovery site
REL_MON	Month of release
REL_SITE	Release site
REL_YR	Year of release

Table 3A. Number of Release Groups and Number of Fish Released by Habitat Cluster

CLUSTER	Number of Release Groups	Mean Number Released	Standard Deviation
AG	93	291.77	177.18
MDRY	457	95.01	141.60
TRAN	1647	62.63	128.23
WILD	614	181.73	211.95
YDRY	505	72.25	106.23

Table 3B. Recoveries by Habitat Cluster and Recovery Site

CLUSTER	REC_SITE	Mean Observed Recoveries	Standard Deviation	Mean Proportion Recovered (Observed)	Standard Deviation	Mean Proportion Recovered, Expanded for Spill	Standard Deviation
AG	LGR	28.94	15.93	0.12	0.09	0.14	0.15
AG	LGS	12.16	9.61	0.05	0.05	0.06	0.08
AG	MCN	6.32	8.00	0.02	0.02	0.03	0.02
MDRY	LGR	7.35	11.69	0.08	0.07	0.10	0.08
MDRY	LGS	2.55	4.62	0.03	0.04	0.04	0.05
MDRY	MCN	1.03	1.94	0.01	0.02	0.01	0.02
TRAN	LGR	4.51	9.65	0.08	0.18	0.09	0.18
TRAN	LGS	2.06	4.48	0.04	0.11	0.05	0.15
TRAN	MCN	0.76	2.21	0.02	0.09	0.02	0.11
WILD	LGR	18.36	18.88	0.13	0.13	0.15	0.13
WILD	LGS	6.09	6.88	0.04	0.04	0.05	0.05
WILD	MCN	2.58	3.57	0.02	0.03	0.02	0.03
YDRY	LGR	7.84	13.45	0.15	0.26	0.24	0.55
YDRY	LGS	3.40	6.31	0.09	0.21	0.13	0.31
YDRY	MCN	1.13	2.70	0.03	0.09	0.05	0.16

Table 4. Summary Statistics and Pearson Correlations Among Independent Variables, Entire Dataset

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
KM_T_LGR	3316	538.69	200.01	1786282	162.00	777.00
LEN_AVGM	3316	84.50	15.95	280213	58.64	195.80
M_FL_15	3316	82.20	21.27	272585	32.22	157.35
AVGFLOW	3316	0.00	1.00	0	-12.21	2.93
AVGPREC	3316	0.00	1.00	0	-12.21	2.93
MAX_SNOW	3316	0.00	1.00	0	-12.21	2.36
	KM_T_LGR	LEN_AVGM	M_FL_15	AVGFLOW	AVGPREC	MAX_SNOW
KM_T_LGR	1.00					
LEN_AVGM	0.14	1.00				
M_FL_15	-0.06	-0.20	1.00			
AVGFLOW	0.00	0.07	-0.16	1.00		
AVGPREC	0.00	-0.02	0.53	-0.30	1.00	
MAX_SNOW	0.00	-0.05	0.24	-0.71	0.52	1.00

Table 5. Summary Statistics and Pearson Correlations Among Independent Variables by Habitat Cluster

AG						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
KM_T_LGR	93.00	288.13	26.93	26796.00	271.00	330.00
LEN_AVGM	93.00	77.98	6.57	7252.00	65.52	93.58
M_FL_15	93.00	85.25	25.88	7928.00	46.09	137.94
AVGFLOW	93.00	0.00	0.99	0.00	-0.97	2.00
AVGPREC	93.00	0.00	0.99	0.00	-1.82	1.54
MAX_SNOW	93.00	0.00	0.99	0.00	-2.01	1.07
	KM_T_LGR	LEN_AVGM	M_FL_15	AVGFLOW	AVGPREC	MAX_SNOW
KM_T_LGR	1					
LEN_AVGM	0.16	1.00				
M_FL_15	0.00	-0.42	1.00			
AVGFLOW	0.00	-0.42	0.35	1.00		
AVGPREC	0.00	-0.35	0.42	0.41	1.00	
MAX_SNOW	0	0.01	0	-0.01	-0.43	1.00
MDRY						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
KM_T_LGR	457	401.29	8	183388.00	400.00	449.00
LEN_AVGM	457	73.89	9	33768.00	58.64	100.00
M_FL_15	457	85.29	20	38977.00	45.54	144.13
AVGFLOW	457	0.00	1	0.00	-12.21	1.58
AVGPREC	457	0.00	1	0.00	-12.21	2.08
MAX_SNOW	457	0.00	1	0.00	-12.21	1.57
	KM_T_LGR	LEN_AVGM	M_FL_15	AVGFLOW	AVGPREC	MAX_SNOW
KM_T_LGR	1.00					
LEN_AVGM	-0.15	1.00				
M_FL_15	0	0.26	1.00			
AVGFLOW	0	-0.41	-1	1.00		
AVGPREC	0.00	0.18	0.62	-0.27	1.00	
MAX_SNOW	0.00	0.27	0.66	-0.32	0.91	1.00
TRAN						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
KM_T_LGR	1647	649.44171	182.08142	1069631	162	777
LEN_AVGM	1647	91.22032	18.36039	150240	60.21	195.8
M_FL_15	1647	80.21263	22.14717	132110	32.21686	133.14463
AVGFLOW	1647	0	0.99726	0	-2.39283	2.92695
AVGPREC	1647	0	0.99726	0	-1.71391	2.92695
MAX_SNOW	1647	0	0.99726	0	-2.92695	1.71391
	KM_T_LGR	LEN_AVGM	M_FL_15	AVGFLOW	AVGPREC	MAX_SNOW
KM_T_LGR	1.00					
LEN_AVGM	-0.12116	1.00				
M_FL_15	0.06598	-0.35722	1.00			
AVGFLOW	0	0.07991	-0.28765	1.00		
AVGPREC	0	-0.06568	0.46434	-0.5482	1.00	
MAX_SNOW	0	-0.06217	0.33123	-0.85476	0.57165	1.00

Table 5 (Concluded)

WILD						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
KM_T_LGR	614	589.17264	97.98924	361752	245	633
LEN_AVGM	614	77.58421	8.47969	47637	60.825	109.31
M_FL_15	614	81.52441	16.57278	50056	45.14336	157.346
AVGFLOW	614	0	0.99509	0	-2.44171	1.7898
AVGPREC	614	0	0.99509	0	-2.06592	2.09833
MAX_SNOW	614	0	0.99509	0	-1.92446	2.36229
	KM_T_LGR	LEN_AVGM	M_FL_15	AVGFLOW	AVGPREC	MAX_SNOW
KM_T_LGR	1.00					
LEN_AVGM	0.14598	1.00				
M_FL_15	-0.12124	0.07662	1.00			
AVGFLOW	0	0.24803	-0.52052	1.00		
AVGPREC	0	-0.18766	0.52829	-0.68359	1.00	
MAX_SNOW	0	-0.20001	0.46059	-0.81382	0.82496	1.00
YDRY						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
KM_T_LGR	505	286.56436	86.04106	144715	171	416
LEN_AVGM	505	81.81466	8.86498	41316	61.18	112.23
M_FL_15	505	86.16688	22.75573	43514	47.2819	149.53877
AVGFLOW	505	0	0.99801	0	-2.68583	2.74029
AVGPREC	505	0	0.99801	0	-2.18293	1.88937
MAX_SNOW	505	0	0.99801	0	-1.60729	1.14677
	KM_T_LGR	LEN_AVGM	M_FL_15	AVGFLOW	AVGPREC	MAX_SNOW
KM_T_LGR	1.00					
LEN_AVGM	-0.26121	1.00				
M_FL_15	-0.04963	0.3434	1.00			
AVGFLOW	0	0.41441	0.79347	1.00		
AVGPREC	0	0.27702	0.74067	0.81573	1.00	
MAX_SNOW	0	-0.22429	-0.62117	-0.58166	-0.20137	1.00

Table 6. Goodness of Fit Statistics- Models 1A-2B

Model Number	1A	1B	2A	2B
Model Description	Year and Release Site Effects, All Observations	Year and Release Site Effects, After Outlier Deletion	Year and Cluster, All Observations	Year and Cluster, After Outlier Deletion
Observations	3316	3272	3316	3271
Null Model Deviance	17464.554	16646.963	17464.554	15769.713
Number of Parameters	169	167	62	62
D.O.F.	3147	3105	3254	3209
Scale Parameter, SQRT(PHI)	1.2651	1.1748	1.4015	1.2446
Deviance	5036.9665	4285.6792	6391.1498	4971.087
Proportion of Deviance Explained By Model	0.712	0.743	0.634	0.685
Pearson Chi-Square	6504.1327	4517.1193	9069.3598	5362.8545
Scaled Pearson Chi-Square	4063.87	3272.91	4617.32	3462.07
Log-likelihood from SAS	14459.525	16538.097	11438.509	14136.086
Correction (Sum(log(Y!)))	28672.799	27999.840	28672.799	27395.170
Corrected Log-Likelihood	-3455.623	-3749.362	-3159.173	-3549.294
AIC	7249.245	7832.724	6442.345	7222.588
BIC	8281.246	8850.281	6820.949	7600.345

Table 7. Goodness of Fit Statistics- Models 3A-5B

Model Number	3A	3B	4A	4B	5A	5B
Model Description	Cluster & Snowpack, All Observations	Cluster & Snowpack, After Outlier Deletion	Cluster & Precipitation, All Observations	Cluster & Precipitation, After Outlier Deletion	Cluster & Subbasin Flow, All Observations	Cluster & Subbasin Flow, After Outlier Deletion
Observations	3316	3265	3316	3268	3316	3273
Null Model Deviance	17464.55	15352.2	17464.55	15359.88	17464.55	15948.89
Number of Parameters	44	44	44	44	44	44
D.O.F.	3272	3221	3272	3224	3272	3229
Scale Parameter, SQRT(PHI)	1.4641	1.2778	1.4704	1.2771	1.4287	1.2733
Deviance	7013.909	5258.948	7074.1	5258.503	6679.029	5235.253
Proportion of Deviance Explained By Model	0.598	0.657	0.595	0.658	0.618	0.672
Pearson Chi-Square	10528.65	5806.312	10490.44	5810.363	10077.65	5805.801
Scaled Pearson Chi-Square	4911.69	3556.11	4852.02	3562.49	4937.16	3580.97
Log-likelihood from SAS	10335.290	12875.08	10233.43	12842.85	10935.52	13532.69
Correction (Sum(log(Y!)))	28672.799	26647.67	28672.799	26577.36	28672.799	27574.91
Corrected Log-Likelihood	-3040.782	-3445.419	-3028.266	-3452.436	-3111.623	-3475.285
AIC	6169.564	6978.838	6144.532	6992.872	6311.247	7038.570
BIC	6438.250	7246.843	6413.219	7260.917	6579.933	7306.682

Table 8. Analysis of Deviance- Models 2A-2B

Model 2A: Cluster and Release Year						
Source	NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER	4	3254	5.9746	0.0001	23.8986	0.0001
REC_SITE	2	3254	2214.6707	0.0001	4429.3414	0.0001
KM_T_LGR	1	3254	0.6048	0.4368	0.6048	0.4368
REL_MON	4	3254	0.9146	0.4544	3.6583	0.4542
LEN_AVGM	1	3254	23.4294	0.0001	23.4294	0.0001
REL_YR	7	3254	26.4945	0.0001	185.4616	0.0001
KM_T_LGR*CLUSTER	4	3254	9.2498	0.0001	36.999	0.0001
CLUSTER*REL_MON	13	3254	5.5534	0.0001	72.1938	0.0001
LEN_AVGM*CLUSTER	4	3254	4.8556	0.0007	19.4225	0.0006
CLUSTER*REL_YR	21	3254	9.7719	0.0001	205.2089	0.0001
Model 2B: Cluster and Release Year, After Outlier Deletion						
Source	NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER	4	3209	5.8669	0.0001	23.4677	0.0001
REC_SITE	2	3209	2752.0848	0.0001	5504.1697	0.0001
KM_T_LGR	1	3209	0.6614	0.4161	0.6614	0.4161
REL_MON	4	3209	1.0799	0.3647	4.3196	0.3645
LEN_AVGM	1	3209	34.1103	0.0001	34.1103	0.0001
REL_YR	7	3209	33.7291	0.0001	236.1034	0.0001
KM_T_LGR*CLUSTER	4	3209	9.0187	0.0001	36.0748	0.0001
CLUSTER*REL_MON	13	3209	5.2398	0.0001	68.1169	0.0001
LEN_AVGM*CLUSTER	4	3209	5.9716	0.0001	23.8866	0.0001
CLUSTER*REL_YR	21	3209	12.0673	0.0001	253.4141	0.0001

Table 9. Analysis of Deviance, Models 3A-5B

Model 3A: Cluster and Snowpack		NDF	DDF	F	Pr>F	chi-square	Pr>Chi
Source							
CLUSTER	4	3272	9.9784	0.0001	39.9135	0.0001	
REC_SITE	2	3272	1700.3925	0.0001	3400.7851	0.0001	
KM_T_LGR	1	3272	0.0296	0.8634	0.0296	0.8634	
REL_MON	4	3272	1.4008	0.2311	5.6031	0.2308	
LEN_AVGM	1	3272	74.7246	0.0001	74.7246	0.0001	
M_FL_15	1	3272	20.8785	0.0001	20.8785	0.0001	
MAX_SNOW	1	3272	4.4679	0.0346	4.4679	0.0345	
KM_T_LGR*CLUSTER	4	3272	15.2542	0.0001	61.0168	0.0001	
CLUSTER*REL_MON	13	3272	6.2514	0.0001	81.2683	0.0001	
LEN_AVGM*CLUSTER	4	3272	7.828	0.0001	31.3119	0.0001	
M_FL_15*CLUSTER	4	3272	14.8977	0.0001	59.5906	0.0001	
MAX_SNOW*CLUSTER	4	3272	9.0315	0.0001	36.126	0.0001	
Model 3B: Cluster and Snowpack after Outlier Deletion							
Source		NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER	4	3221	13.4069	0.0001	53.6277	0.0001	
REC_SITE	2	3221	2149.147	0.0001	4298.2939	0.0001	
KM_T_LGR	1	3221	0.1206	0.7284	0.1206	0.7284	
REL_MON	4	3221	3.1873	0.0127	12.7491	0.0126	
LEN_AVGM	1	3221	112.0267	0.0001	112.0267	0.0001	
M_FL_15	1	3221	42.4877	0.0001	42.4877	0.0001	
MAX_SNOW	1	3221	1.5377	0.215	1.5377	0.215	
KM_T_LGR*CLUSTER	4	3221	17.5723	0.0001	70.2891	0.0001	
CLUSTER*REL_MON	13	3221	5.7013	0.0001	74.1171	0.0001	
LEN_AVGM*CLUSTER	4	3221	11.1864	0.0001	44.7456	0.0001	
M_FL_15*CLUSTER	4	3221	8.4563	0.0001	33.825	0.0001	
MAX_SNOW*CLUSTER	4	3221	6.4393	0.0001	25.7573	0.0001	

Table 9 (Continued)

Model 4A: Cluster and Precipitation							
Source		NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER		4	3272	8.8011	0.0001	35.2043	0.0001
REC_SITE		2	3272	1629.3421	0.0001	3258.6842	0.0001
KM_T_LGR		1	3272	1.1824	0.277	1.1824	0.2769
REL_MON		4	3272	1.5675	0.1802	6.27	0.1799
LEN_AVGM		1	3272	67.9125	0.0001	67.9125	0.0001
M_FL_15		1	3272	46.325	0.0001	46.325	0.0001
AVGPREC		1	3272	10.3266	0.0013	10.3266	0.0013
KM_T_LGR*CLUSTER		4	3272	16.339	0.0001	65.356	0.0001
CLUSTER*REL_MON		13	3272	5.3165	0.0001	69.1144	0.0001
LEN_AVGM*CLUSTER		4	3272	7.2953	0.0001	29.1813	0.0001
M_FL_15*CLUSTER		4	3272	5.0243	0.0005	20.0971	0.0005
AVGPREC*CLUSTER		4	3272	3.4533	0.008	13.8133	0.0079
Model 4B: Cluster and Precipitation After Outlier Deletion							
Source		NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER		4	3224	12.3607	0.0001	49.4427	0.0001
REC_SITE		2	3224	2110.4471	0.0001	4220.8943	0.0001
KM_T_LGR		1	3224	1.1257	0.2888	1.1257	0.2887
REL_MON		4	3224	1.7428	0.1377	6.9713	0.1374
LEN_AVGM		1	3224	94.6869	0.0001	94.6869	0.0001
M_FL_15		1	3224	51.0232	0.0001	51.0232	0.0001
AVGPREC		1	3224	6.0371	0.0141	6.0371	0.014
KM_T_LGR*CLUSTER		4	3224	15.3809	0.0001	61.5235	0.0001
CLUSTER*REL_MON		13	3224	4.6065	0.0001	59.8844	0.0001
LEN_AVGM*CLUSTER		4	3224	9.7611	0.0001	39.0444	0.0001
M_FL_15*CLUSTER		4	3224	6.1218	0.0001	24.487	0.0001
AVGPREC*CLUSTER		4	3224	4.5746	0.0011	18.2982	0.0011

Table 9 (Concluded)

Model 5A: Cluster and Subbasin Flow							
Source		NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER		4	3272	8.6064	0.0001	34.4256	0.0001
REC_SITE		2	3272	1802.1098	0.0001	3604.2196	0.0001
KM_T_LGR		1	3272	0.691	0.4059	0.691	0.4058
REL_MON		4	3272	0.4913	0.7421	1.9654	0.7421
LEN_AVGM		1	3272	47.7748	0.0001	47.7748	0.0001
M_FL_15		1	3272	6.1628	0.0131	6.1628	0.013
AVGFLOW		1	3272	86.109	0.0001	86.109	0.0001
KM_T_LGR*CLUSTER		4	3272	11.3702	0.0001	45.4809	0.0001
CLUSTER*REL_MON		13	3272	4.6914	0.0001	60.9887	0.0001
LEN_AVGM*CLUSTER		4	3272	5.6976	0.0001	22.7903	0.0001
M_FL_15*CLUSTER		4	3272	40.5283	0.0001	162.1131	0.0001
AVGFLOW*CLUSTER		4	3272	30.5841	0.0001	122.3363	0.0001
Model 5B: Cluster and Subbasin Flow After Outlier Deletion							
Source		NDF	DDF	F	Pr>F	chi-square	Pr>Chi
CLUSTER		4	3229	9.8434	0.0001	39.3735	0.0001
REC_SITE		2	3229	2242.9212	0.0001	4485.8423	0.0001
KM_T_LGR		1	3229	0.4591	0.4981	0.4591	0.4981
REL_MON		4	3229	0.5125	0.7265	2.0501	0.7265
LEN_AVGM		1	3229	55.4507	0.0001	55.4507	0.0001
M_FL_15		1	3229	9.9544	0.0016	9.9544	0.0016
AVGFLOW		1	3229	124.4093	0.0001	124.4093	0.0001
KM_T_LGR*CLUSTER		4	3229	12.213	0.0001	48.8519	0.0001
CLUSTER*REL_MON		13	3229	4.2468	0.0001	55.209	0.0001
LEN_AVGM*CLUSTER		4	3229	6.4796	0.0001	25.9185	0.0001
M_FL_15*CLUSTER		4	3229	39.1517	0.0001	156.607	0.0001
AVGFLOW*CLUSTER		4	3229	40.4847	0.0001	161.9388	0.0001

Table 10. Models 3B, 4B, and 5B Habitat Cluster and Climate Variable Parameter Estimates

Model 3B - Snowpack						
Parameter	CLUSTER	DF	Estimate	Std Err	chi-square	Pr>Chi
CLUSTER	AG	1	0.600	1.189	0.254	0.6143
CLUSTER	MDRY	1	0.278	1.134	0.060	0.8061
CLUSTER	TRAN	1	3.506	0.593	34.910	0.0001
CLUSTER	WILD	1	2.176	0.700	9.658	0.0019
CLUSTER	YDRY	0	0.000	0.000	.	.
M_FL_15		1	0.002	0.002	0.736	0.3908
MAX_SNOW		1	0.139	0.036	14.672	0.0001
M_FL_15*CLUSTER	AG	1	-0.008	0.003	8.577	0.0034
M_FL_15*CLUSTER	MDRY	1	-0.006	0.003	3.897	0.0484
M_FL_15*CLUSTER	TRAN	1	-0.008	0.002	15.049	0.0001
M_FL_15*CLUSTER	WILD	1	-0.013	0.002	32.527	0.0001
M_FL_15*CLUSTER	YDRY	0	0.000	0.000	.	.
MAX_SNOW*CLUSTER	AG	1	-0.266	0.056	22.259	0.0001
MAX_SNOW*CLUSTER	MDRY	1	-0.131	0.054	5.751	0.0165
MAX_SNOW*CLUSTER	TRAN	1	-0.080	0.042	3.618	0.0571
MAX_SNOW*CLUSTER	WILD	1	-0.126	0.041	9.291	0.0023
MAX_SNOW*CLUSTER	YDRY	0	0.000	0.000	.	.
Model 4B - Average Precipitation						
Parameter	CLUSTER	DF	Estimate	Std Err	chi-square	Pr>Chi
CLUSTER	AG	1	0.956	1.131	0.715	0.3978
CLUSTER	MDRY	1	-1.476	1.163	1.612	0.2042
CLUSTER	TRAN	1	3.086	0.580	28.333	0.0001
CLUSTER	WILD	1	1.532	0.688	4.955	0.026
CLUSTER	YDRY	0	0.000	0.000	.	.
M_FL_15		1	0.004	0.003	1.986	0.1587
AVGPREC		1	-0.052	0.043	1.467	0.2258
M_FL_15*CLUSTER	AG	1	-0.012	0.003	14.052	0.0002
M_FL_15*CLUSTER	MDRY	1	-0.014	0.004	15.195	0.0001
M_FL_15*CLUSTER	TRAN	1	-0.011	0.003	16.812	0.0001
M_FL_15*CLUSTER	WILD	1	-0.014	0.003	23.059	0.0001
M_FL_15*CLUSTER	YDRY	0	0.000	0.000	.	.
AVGPREC*CLUSTER	AG	1	0.104	0.059	3.167	0.0751
AVGPREC*CLUSTER	MDRY	1	0.230	0.063	13.347	0.0003
AVGPREC*CLUSTER	TRAN	1	0.092	0.051	3.302	0.0692
AVGPREC*CLUSTER	WILD	1	0.039	0.048	0.637	0.4247
AVGPREC*CLUSTER	YDRY	0	0.000	0.000	.	.

Table 10 (Concluded)

Model 5B - Subbasin Flow						
Parameter	CLUSTER	DF	Estimate	Std Err	chi-square	Pr>Chi
CLUSTER	AG	1	1.610	1.158	1.934	0.1643
CLUSTER	MDRY	1	-0.141	1.143	0.015	0.9019
CLUSTER	TRAN	1	2.841	0.602	22.264	0.0001
CLUSTER	WILD	1	1.409	0.707	3.967	0.0464
CLUSTER	YDRY	0	0.000	0.000	.	.
M_FL_15		1	0.017	0.002	72.955	0.0001
AVGFLOW		1	-0.529	0.033	256.270	0.0001
M_FL_15*CLUSTER	AG	1	-0.022	0.003	61.786	0.0001
M_FL_15*CLUSTER	MDRY	1	-0.024	0.003	61.528	0.0001
M_FL_15*CLUSTER	TRAN	1	-0.024	0.002	116.403	0.0001
M_FL_15*CLUSTER	WILD	1	-0.029	0.002	154.254	0.0001
M_FL_15*CLUSTER	YDRY	0	0.000	0.000	.	.
AVGFLOW*CLUSTER	AG	1	0.409	0.057	51.391	0.0001
AVGFLOW*CLUSTER	MDRY	1	0.446	0.050	80.051	0.0001
AVGFLOW*CLUSTER	TRAN	1	0.424	0.039	118.045	0.0001
AVGFLOW*CLUSTER	WILD	1	0.483	0.039	157.102	0.0001
AVGFLOW*CLUSTER	YDRY	0	0.000	0.000	.	.

Figure 1. Map of Release Sites and Climate Stations

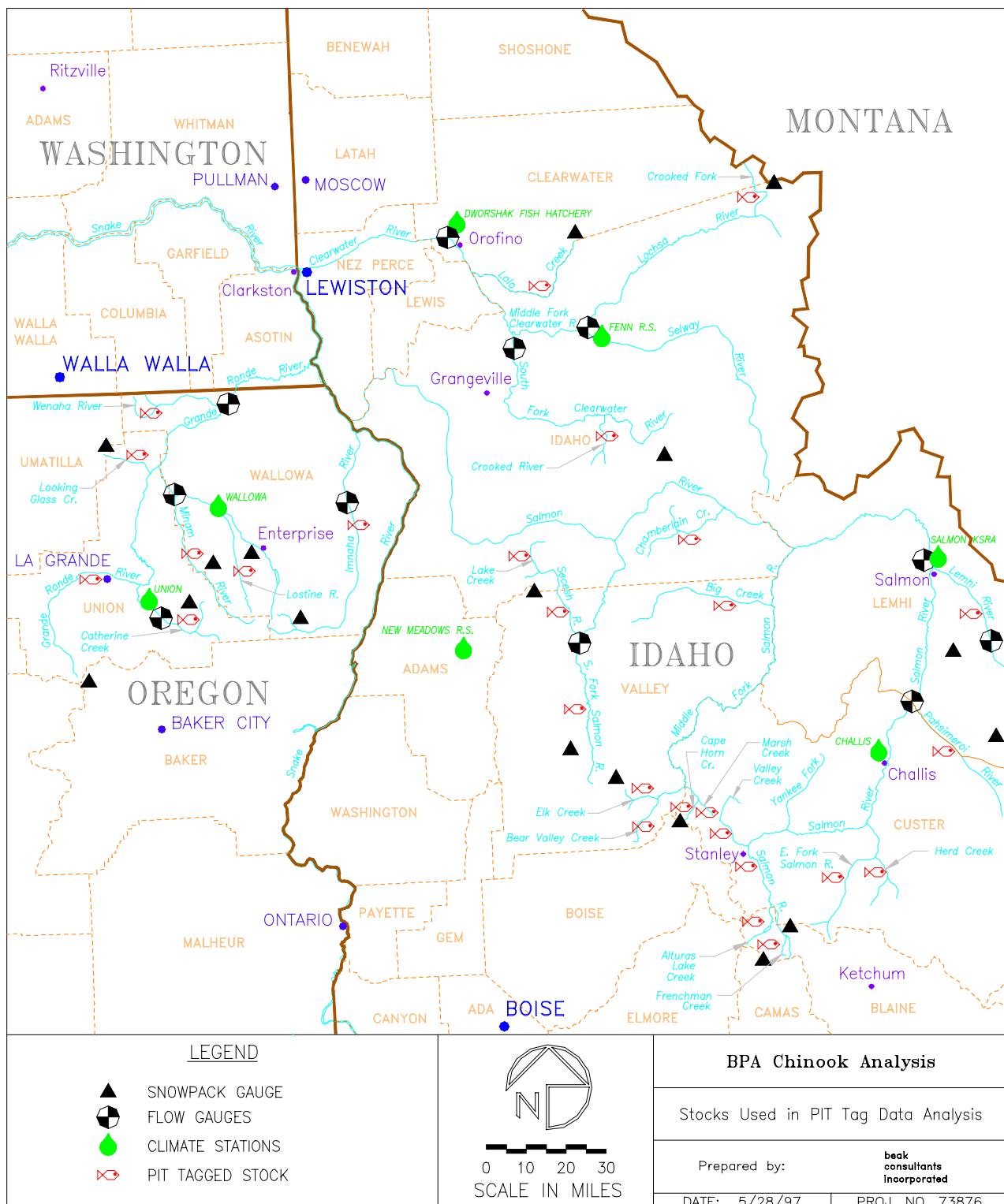
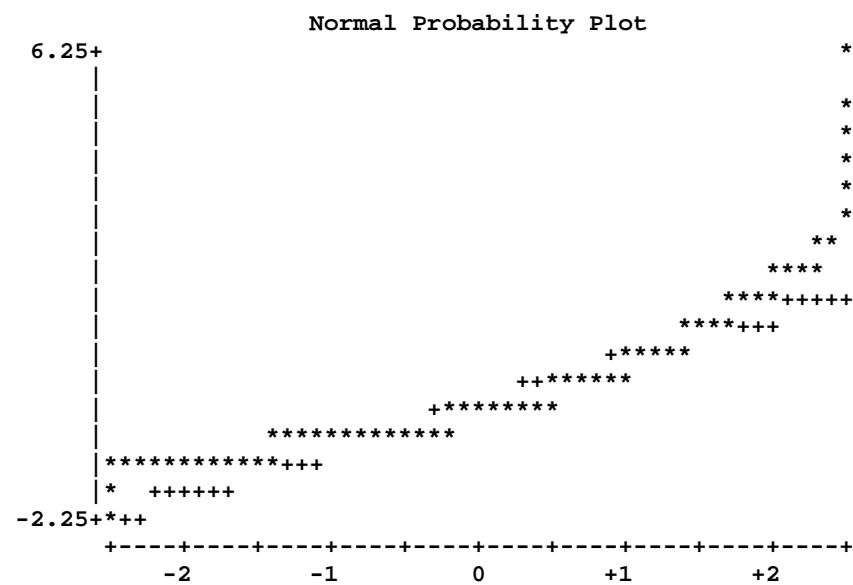
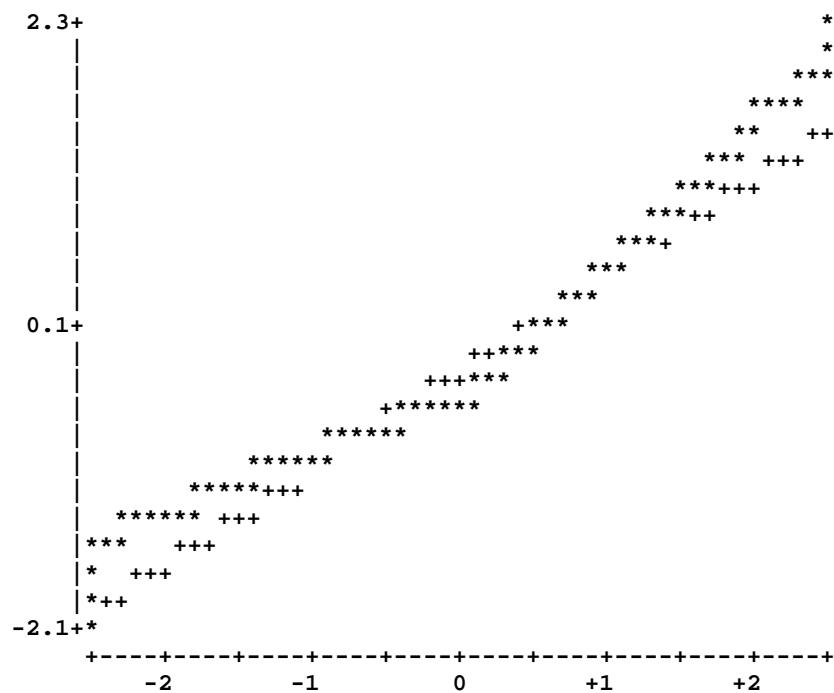


Figure 2.

Anscombe Residuals Normal Probability Plot- Model 2A



Anscombe Residuals Normal Probability Plot- Model 2B After Outlier Deletion



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Appendix: Detailed Model Results

Model 2A

REL_YR , Cluster, and Interactions
PRIOR TO OUTLIER DELETION

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	chi-square	
Pr>Chi						
INTERCEPT		1	-6.0644	0.7268	69.6293 0.0001	
CLUSTER	AG	1	0.1908	1.6283	0.0137 0.9067	
CLUSTER	MDRY	1	-0.7435	1.5740	0.2231 0.6367	
CLUSTER	TRAN	1	1.0147	0.7504	1.8283 0.1763	
CLUSTER	WILD	1	-1.4629	0.8702	2.8259 0.0928	
CLUSTER	YDRY	0	0.0000	0.0000	.	
REC_SITE	LGR	1	2.0557	0.0392	2753.6175 0.0001	
REC_SITE	LGS	1	1.0053	0.0431	544.3212 0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	
KM_T_LGR		1	0.0002	0.0006	0.1085 0.7419	
REL_MON	7	1	-1.2442	0.5406	5.2976 0.0214	
REL_MON	8	1	-0.3404	0.1456	5.4634 0.0194	
REL_MON	9	1	-0.0972	0.0993	0.9584 0.3276	
REL_MON	10	1	0.2296	0.1234	3.4627 0.0628	
REL_MON	11	0	0.0000	0.0000	.	
LEN_AVGM		1	0.0220	0.0066	11.0000 0.0009	
REL_YR	1988	1	1.4292	0.1531	87.1794 0.0001	
REL_YR	1989	1	0.9320	0.1595	34.1434 0.0001	
REL_YR	1990	1	0.9607	0.1646	34.0891 0.0001	
REL_YR	1991	1	0.9869	0.1629	36.7171 0.0001	
REL_YR	1992	1	0.1138	0.1483	0.5890 0.4428	
REL_YR	1993	1	-0.2031	0.1243	2.6698 0.1023	
REL_YR	1994	1	-0.3083	0.1245	6.1294 0.0133	
REL_YR	1995	0	0.0000	0.0000	.	
KM_T_LGR*CLUSTER	AG	1	-0.0066	0.0015	18.6662 0.0001	
KM_T_LGR*CLUSTER	MDRY	1	0.0043	0.0034	1.5816 0.2085	
KM_T_LGR*CLUSTER	TRAN	1	-0.0012	0.0006	4.6065 0.0319	
KM_T_LGR*CLUSTER	WILD	1	-0.0002	0.0006	0.1585 0.6906	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	
CLUSTER*REL_MON	AG	8	1.0517	0.7344	2.0506 0.1521	
CLUSTER*REL_MON	AG	9	0.5371	0.7204	0.5559 0.4559	
CLUSTER*REL_MON	AG	10	0.0000	0.0000	.	
CLUSTER*REL_MON	MDRY	8	0.0703	0.2684	0.0685 0.7935	
CLUSTER*REL_MON	MDRY	9	0.1445	0.2130	0.4604 0.4974	
CLUSTER*REL_MON	MDRY	10	1.053	0.2193	0.2304 0.6312	
CLUSTER*REL_MON	MDRY	11	0.0000	0.0000	.	
CLUSTER*REL_MON	TRAN	7	0.9655	0.6631	2.1196 0.1454	
CLUSTER*REL_MON	TRAN	8	-0.0166	0.1737	0.0092 0.9237	
CLUSTER*REL_MON	TRAN	9	-0.5706	0.1295	19.4090 0.0001	
CLUSTER*REL_MON	TRAN	10	-0.4778	0.1428	11.1935 0.0008	
CLUSTER*REL_MON	TRAN	11	0.0000	0.0000	.	
CLUSTER*REL_MON	WILD	7	1.5177	0.6353	5.7066 0.0169	
CLUSTER*REL_MON	WILD	8	0.5952	0.3542	2.8240 0.0929	
CLUSTER*REL_MON	WILD	9	0.3452	0.3316	1.0837 0.2979	
CLUSTER*REL_MON	WILD	10	-0.0663	0.3415	0.0377 0.8460	
CLUSTER*REL_MON	WILD	11	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	7	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	8	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	9	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	10	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	11	0.0000	0.0000	.	
LEN_AVGM*CLUSTER	AG	1	0.0078	0.0164	0.2250 0.6353	
LEN_AVGM*CLUSTER	MDRY	1	-0.0179	0.0108	2.7306 0.0984	
LEN_AVGM*CLUSTER	TRAN	1	-0.0124	0.0069	3.2365 0.0720	
LEN_AVGM*CLUSTER	WILD	1	0.0060	0.0078	0.5835 0.4450	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	
CLUSTER*REL_YR	AG	1989	1	-0.2535	0.4881	0.2697 0.6036
CLUSTER*REL_YR	AG	1990	1	-0.4281	0.2548	2.8231 0.0929
CLUSTER*REL_YR	AG	1991	1	-0.1536	0.2664	0.3325 0.5642
CLUSTER*REL_YR	AG	1992	1	0.1642	0.2477	0.4396 0.5073

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Model 2A (Concluded)

REL_YR , Cluster, and Interactions
PRIOR TO OUTLIER DELETION

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	chi-square	
Pr>Chi						
CLUSTER*REL_YR	AG 1993	1	0.6286	0.2132	8.6950	0.0032
CLUSTER*REL_YR	AG 1994	1	0.6982	0.2101	11.0426	0.0009
CLUSTER*REL_YR	AG 1995	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	MDRY 1988	1	-1.1768	0.2530	21.6385	0.0001
CLUSTER*REL_YR	MDRY 1990	1	-0.3733	0.2695	1.9191	0.1660
CLUSTER*REL_YR	MDRY 1991	1	-0.5383	0.2699	3.9780	0.0461
CLUSTER*REL_YR	MDRY 1992	1	0.2042	0.2168	0.8876	0.3461
CLUSTER*REL_YR	MDRY 1993	1	0.1297	0.1390	0.8711	0.3507
CLUSTER*REL_YR	MDRY 1994	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	TRAN 1988	1	-0.6268	0.1863	11.3260	0.0008
CLUSTER*REL_YR	TRAN 1989	1	-0.0957	0.1918	0.2491	0.6177
CLUSTER*REL_YR	TRAN 1990	1	-0.8424	0.2041	17.0285	0.0001
CLUSTER*REL_YR	TRAN 1991	1	-0.3189	0.1895	2.8332	0.0923
CLUSTER*REL_YR	TRAN 1992	1	0.3080	0.1776	3.0081	0.0828
CLUSTER*REL_YR	TRAN 1993	1	0.5681	0.1494	14.4547	0.0001
CLUSTER*REL_YR	TRAN 1994	1	0.5573	0.1554	12.8580	0.0003
CLUSTER*REL_YR	TRAN 1995	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	WILD 1989	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	WILD 1990	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	WILD 1991	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	WILD 1992	1	0.2479	0.2102	1.3911	0.2382
CLUSTER*REL_YR	WILD 1993	1	1.0426	0.1901	30.0817	0.0001
CLUSTER*REL_YR	WILD 1994	1	0.9704	0.1929	25.2970	0.0001
CLUSTER*REL_YR	WILD 1995	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	YDRY 1988	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	YDRY 1992	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	YDRY 1993	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	YDRY 1994	0	0.0000	0.0000	.	.
CLUSTER*REL_YR	YDRY 1995	0	0.0000	0.0000	.	.
SCALE		0	1.4015	0.0000	.	.

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Model 2B

REL_YR CLUSTER,, and Interactions
AFTER OUTLIER DELETION

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	chi-square
Pr>Chi					
INTERCEPT		1	-6.4461	0.6636	94.3664 0.0001
CLUSTER	AG	1	-0.5213	1.4846	0.1233 0.7255
CLUSTER	MDRY	1	-0.6404	1.4042	0.2080 0.6483
CLUSTER	TRAN	1	1.3419	0.6851	3.8358 0.0502
CLUSTER	WILD	1	-0.8631	0.7909	1.1907 0.2752
CLUSTER	YDRY	0	0.0000	0.0000	.
REC_SITE	LGR	1	2.1042	0.0363	3353.7367 0.0001
REC_SITE	LGS	1	1.0489	0.0398	694.5795 0.0001
REC_SITE	MCN	0	0.0000	0.0000	.
KM_T_LGR		1	0.0002	0.0005	0.2112 0.6459
REL_MON	7	1	-1.2089	0.4809	6.3195 0.0119
REL_MON	8	1	-0.2596	0.1323	3.8518 0.0497
REL_MON	9	1	-0.0721	0.0905	0.6350 0.4255
REL_MON	10	1	0.2367	0.1123	4.4415 0.0351
REL_MON	11	0	0.0000	0.0000	.
LEN_AVGM		1	0.0227	0.0060	14.2895 0.0002
REL_YR	1988	1	1.6678	0.1420	137.9311 0.0001
REL_YR	1989	1	0.8854	0.1425	38.6184 0.0001
REL_YR	1990	1	0.8864	0.1478	35.9744 0.0001
REL_YR	1991	1	0.8897	0.1468	36.7344 0.0001
REL_YR	1992	1	0.3177	0.1377	5.3229 0.0210
REL_YR	1993	1	0.0430	0.1178	0.1332 0.7151
REL_YR	1994	1	-0.0726	0.1181	0.3783 0.5385
REL_YR	1995	0	0.0000	0.0000	.
KM_T_LGR*CLUSTER	AG	1	-0.0064	0.0014	20.9941 0.0001
KM_T_LGR*CLUSTER	MDRY	1	0.0042	0.0030	1.9631 0.1612
KM_T_LGR*CLUSTER	TRAN	1	-0.0012	0.0005	5.7090 0.0169
KM_T_LGR*CLUSTER	WILD	1	-0.0005	0.0005	0.7416 0.3891
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.
CLUSTER*REL_MON	AG	8	1	0.9889	0.6539 2.2874 0.1304
CLUSTER*REL_MON	AG	9	1	0.3488	0.6414 0.2958 0.5865
CLUSTER*REL_MON	AG	10	0	0.0000	0.0000 . .
CLUSTER*REL_MON	MDRY	8	1	-0.0106	0.2400 0.0020 0.9646
CLUSTER*REL_MON	MDRY	9	1	0.1194	0.1902 0.3936 0.5304
CLUSTER*REL_MON	MDRY	10	1	-0.1123	0.1963 0.3272 0.5673
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000 . .
CLUSTER*REL_MON	TRAN	7	1	1.0434	0.5900 3.1272 0.0770
CLUSTER*REL_MON	TRAN	8	1	-0.1856	0.1581 1.3786 0.2403
CLUSTER*REL_MON	TRAN	9	1	-0.4995	0.1174 18.1137 0.0001
CLUSTER*REL_MON	TRAN	10	1	-0.4803	0.1298 13.6833 0.0002
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000 . .
CLUSTER*REL_MON	WILD	7	1	1.4430	0.5652 6.5178 0.0107
CLUSTER*REL_MON	WILD	8	1	0.4638	0.3161 2.1526 0.1423
CLUSTER*REL_MON	WILD	9	1	0.2480	0.2954 0.7052 0.4010
CLUSTER*REL_MON	WILD	10	1	-0.0774	0.3043 0.0647 0.7992
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000 . .
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000 . .
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000 . .
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000 . .
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000 . .
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000 . .
LEN_AVGM*CLUSTER	AG	1	0.0174	0.0150	1.3484 0.2455
LEN_AVGM*CLUSTER	MDRY	1	-0.0187	0.0097	3.7125 0.0540
LEN_AVGM*CLUSTER	TRAN	1	-0.0136	0.0063	4.6653 0.0308
LEN_AVGM*CLUSTER	WILD	1	0.0034	0.0071	0.2270 0.6338
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.
CLUSTER*REL_YR	AG	1989	1	0.2028	0.4409 0.2116 0.6455
CLUSTER*REL_YR	AG	1990	1	-0.0409	0.2376 0.0297 0.8633
CLUSTER*REL_YR	AG	1991	1	0.1081	0.2488 0.1886 0.6641
CLUSTER*REL_YR	AG	1992	1	0.1254	0.2322 0.2914 0.5893
CLUSTER*REL_YR	AG	1993	1	0.5226	0.2043 6.5436 0.0105
CLUSTER*REL_YR	AG	1994	1	0.6699	0.2003 11.1885 0.0008

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Model 2B (Concluded)

REL_YR CLUSTER,, and Interactions
AFTER OUTLIER DELETION

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	chi-square
Pr>Chi					
CLUSTER*REL_YR	AG	1995	0	0.0000	0.0000
CLUSTER*REL_YR	MDRY	1988	1	-1.1812	0.2249
CLUSTER*REL_YR	MDRY	1990	1	-0.0629	0.2439
CLUSTER*REL_YR	MDRY	1991	1	-0.2069	0.2445
CLUSTER*REL_YR	MDRY	1992	1	0.2350	0.1937
CLUSTER*REL_YR	MDRY	1993	1	0.1177	0.1236
CLUSTER*REL_YR	MDRY	1994	0	0.0000	0.0000
CLUSTER*REL_YR	TRAN	1988	1	-0.9907	0.1725
CLUSTER*REL_YR	TRAN	1989	1	-0.1357	0.1720
CLUSTER*REL_YR	TRAN	1990	1	-0.7928	0.1841
CLUSTER*REL_YR	TRAN	1991	1	-0.1719	0.1703
CLUSTER*REL_YR	TRAN	1992	1	0.0166	0.1641
CLUSTER*REL_YR	TRAN	1993	1	0.2978	0.1397
CLUSTER*REL_YR	TRAN	1994	1	0.3927	0.1446
CLUSTER*REL_YR	TRAN	1995	0	0.0000	0.0000
CLUSTER*REL_YR	WILD	1989	0	0.0000	0.0000
CLUSTER*REL_YR	WILD	1990	0	0.0000	0.0000
CLUSTER*REL_YR	WILD	1991	0	0.0000	0.0000
CLUSTER*REL_YR	WILD	1992	1	0.0632	0.1908
CLUSTER*REL_YR	WILD	1993	1	0.8028	0.1738
CLUSTER*REL_YR	WILD	1994	1	0.7465	0.1764
CLUSTER*REL_YR	WILD	1995	0	0.0000	0.0000
CLUSTER*REL_YR	YDRY	1988	0	0.0000	0.0000
CLUSTER*REL_YR	YDRY	1992	0	0.0000	0.0000
CLUSTER*REL_YR	YDRY	1993	0	0.0000	0.0000
CLUSTER*REL_YR	YDRY	1994	0	0.0000	0.0000
CLUSTER*REL_YR	YDRY	1995	0	0.0000	0.0000
SCALE		0	1.2446	0.0000	.

NOTE: The scale parameter was estimated by the square root of DDEVIANC/DOF.

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Model 3A

MAX_SNOW, LGR Flow, and Interactions
Prior to outlier delete

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	chi-square	Pr>Chi	
INTERCEPT		1	-7.5327	0.6336	141.3635	0.0001	
CLUSTER	AG	1	0.8643	1.3308	0.4218	0.5160	
CLUSTER	MDRY	1	0.0373	1.2911	0.0008	0.9770	
CLUSTER	TRAN	1	3.3130	0.6624	25.0122	0.0001	
CLUSTER	WILD	1	1.8040	0.7861	5.2658	0.0217	
CLUSTER	YDRY	0	0.0000	0.0000	.	.	
REC_SITE	LGR	1	1.9842	0.0422	2206.9889	0.0001	
REC_SITE	LGS	1	0.9761	0.0453	463.6663	0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	.	
KM_T_LGR		1	0.0022	0.0006	13.7413	0.0002	
REL_MON	7	1	-1.5664	0.5645	7.7014	0.0055	
REL_MON	8	1	-0.2660	0.1474	3.2567	0.0711	
REL_MON	9	1	0.2214	0.0979	5.1135	0.0237	
REL_MON	10	1	0.3271	0.1290	6.4243	0.0113	
REL_MON	11	0	0.0000	0.0000	.	.	
LEN_AVGM		1	0.0233	0.0066	12.4451	0.0004	
M_FL_15		1	0.0068	0.0020	11.4307	0.0007	
MAX_SNOW		1	0.2103	0.0386	29.7087	0.0001	
KM_T_LGR*CLUSTER	AG	1	-0.0063	0.0016	15.6804	0.0001	
KM_T_LGR*CLUSTER	MDRY	1	0.0006	0.0027	0.0513	0.8209	
KM_T_LGR*CLUSTER	TRAN	1	-0.0031	0.0006	25.5576	0.0001	
KM_T_LGR*CLUSTER	WILD	1	-0.0018	0.0006	8.2187	0.0041	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
CLUSTER*REL_MON	AG	8	1.1147	0.7564	2.1717	0.1406	
CLUSTER*REL_MON	AG	9	0.2451	0.7486	0.1072	0.7433	
CLUSTER*REL_MON	AG	10	0	0.0000	.	.	
CLUSTER*REL_MON	MDRY	8	1	0.5536	0.2488	4.9497	0.0261
CLUSTER*REL_MON	MDRY	9	1	-0.0553	0.2171	0.0649	0.7989
CLUSTER*REL_MON	MDRY	10	1	-0.1536	0.2284	0.4522	0.5013
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	TRAN	7	1	1.5969	0.6937	5.2987	0.0213
CLUSTER*REL_MON	TRAN	8	1	0.0415	0.1753	0.0561	0.8128
CLUSTER*REL_MON	TRAN	9	1	-0.5979	0.1238	23.3063	0.0001
CLUSTER*REL_MON	TRAN	10	1	-0.4983	0.1494	11.1283	0.0009
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	WILD	7	1	1.7754	0.6625	7.1819	0.0074
CLUSTER*REL_MON	WILD	8	1	0.4717	0.3665	1.6561	0.1981
CLUSTER*REL_MON	WILD	9	1	-0.0055	0.3448	0.0003	0.9872
CLUSTER*REL_MON	WILD	10	1	-0.1689	0.3568	0.2241	0.6360
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000	.	.
LEN_AVGM*CLUSTER	AG	1	0.0180	0.0120	2.2404	0.1344	
LEN_AVGM*CLUSTER	MDRY	1	0.0024	0.0086	0.0787	0.7791	
LEN_AVGM*CLUSTER	TRAN	1	-0.0157	0.0069	5.2263	0.0222	
LEN_AVGM*CLUSTER	WILD	1	0.0003	0.0077	0.0014	0.9699	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
M_FL_15*CLUSTER	AG	1	-0.0118	0.0029	16.5043	0.0001	
M_FL_15*CLUSTER	MDRY	1	-0.0118	0.0035	11.2906	0.0008	
M_FL_15*CLUSTER	TRAN	1	-0.0126	0.0022	31.9647	0.0001	
M_FL_15*CLUSTER	WILD	1	-0.0186	0.0024	58.9770	0.0001	
M_FL_15*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
MAX_SNOW*CLUSTER	AG	1	-0.3222	0.0607	28.1406	0.0001	
MAX_SNOW*CLUSTER	MDRY	1	-0.1979	0.0605	10.7112	0.0011	
MAX_SNOW*CLUSTER	TRAN	1	-0.1445	0.0452	10.2396	0.0014	
MAX_SNOW*CLUSTER	WILD	1	-0.2121	0.0447	22.5336	0.0001	
MAX_SNOW*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
SCALE		0	1.4641	0.0000	.	.	

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Model 3B

MAX_SNOW LGR Flow, and Interactions
After Outlier Deletions

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	ChiSquare	Pr>Chi	
INTERCEPT		1	-7.8025	0.5683	188.5284	0.0001	
CLUSTER	AG	1	0.5995	1.1894	0.2540	0.6143	
CLUSTER	MDRY	1	0.2784	1.1341	0.0603	0.8061	
CLUSTER	TRAN	1	3.5060	0.5934	34.9102	0.0001	
CLUSTER	WILD	1	2.1759	0.7002	9.6578	0.0019	
CLUSTER	YDRY	0	0.0000	0.0000	.	.	
REC_SITE	LGR	1	2.0389	0.0391	2717.7767	0.0001	
REC_SITE	LGS	1	1.0195	0.0418	594.5194	0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	.	
KM_T_LGR		1	0.0023	0.0006	17.2799	0.0001	
REL_MON	7	1	-1.8357	0.5806	9.9977	0.0016	
REL_MON	8	1	-0.0716	0.1322	0.2937	0.5879	
REL_MON	9	1	0.1370	0.0892	2.3586	0.1246	
REL_MON	10	1	0.2337	0.1172	3.9770	0.0461	
REL_MON	11	0	0.0000	0.0000	.	.	
LEN_AVGM		1	0.0302	0.0059	26.1040	0.0001	
M_FL_15		1	0.0016	0.0019	0.7364	0.3908	
MAX_SNOW		1	0.1391	0.0363	14.6720	0.0001	
KM_T_LGR*CLUSTER	AG	1	-0.0058	0.0014	16.3028	0.0001	
KM_T_LGR*CLUSTER	MDRY	1	0.0005	0.0024	0.0356	0.8504	
KM_T_LGR*CLUSTER	TRAN	1	-0.0032	0.0006	32.0743	0.0001	
KM_T_LGR*CLUSTER	WILD	1	-0.0020	0.0006	11.6395	0.0006	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
CLUSTER*REL_MON	AG	8	1	0.8511	0.6618	1.6540	0.1984
CLUSTER*REL_MON	AG	9	1	0.1243	0.6550	0.0360	0.8495
CLUSTER*REL_MON	AG	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	MDRY	8	1	0.3593	0.2192	2.6857	0.1013
CLUSTER*REL_MON	MDRY	9	1	0.0270	0.1912	0.0199	0.8878
CLUSTER*REL_MON	MDRY	10	1	-0.0618	0.2020	0.0936	0.7596
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	TRAN	7	1	1.8637	0.6792	7.5294	0.0061
CLUSTER*REL_MON	TRAN	8	1	-0.2307	0.1571	2.1566	0.1420
CLUSTER*REL_MON	TRAN	9	1	-0.5173	0.1117	21.4429	0.0001
CLUSTER*REL_MON	TRAN	10	1	-0.4371	0.1351	10.4675	0.0012
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	WILD	7	1	1.9755	0.6549	9.0998	0.0026
CLUSTER*REL_MON	WILD	8	1	0.1981	0.3215	0.3797	0.5378
CLUSTER*REL_MON	WILD	9	1	0.0153	0.3022	0.0026	0.9596
CLUSTER*REL_MON	WILD	10	1	-0.0837	0.3131	0.0715	0.7892
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000	.	.
LEN_AVGM*CLUSTER	AG	1	0.0174	0.0109	2.5742	0.1086	
LEN_AVGM*CLUSTER	MDRY	1	-0.0046	0.0076	0.3626	0.5471	
LEN_AVGM*CLUSTER	TRAN	1	-0.0220	0.0062	12.8224	0.0003	
LEN_AVGM*CLUSTER	WILD	1	-0.0082	0.0069	1.4042	0.2360	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
M_FL_15*CLUSTER	AG	1	-0.0078	0.0027	8.5773	0.0034	
M_FL_15*CLUSTER	MDRY	1	-0.0062	0.0031	3.8974	0.0484	
M_FL_15*CLUSTER	TRAN	1	-0.0079	0.0020	15.0487	0.0001	
M_FL_15*CLUSTER	WILD	1	-0.0126	0.0022	32.5272	0.0001	
M_FL_15*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
MAX_SNOW*CLUSTER	AG	1	-0.2657	0.0563	22.2591	0.0001	
MAX_SNOW*CLUSTER	MDRY	1	-0.1306	0.0544	5.7513	0.0165	
MAX_SNOW*CLUSTER	TRAN	1	-0.0801	0.0421	3.6182	0.0571	
MAX_SNOW*CLUSTER	WILD	1	-0.1263	0.0414	9.2910	0.0023	
MAX_SNOW*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
SCALE		0	1.2778	0.0000	.	.	

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Model 4A

AVGPREC LGR Flow, and Interactions
Prior to outlier delete

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	ChiSquare	Pr>Chi	
INTERCEPT		1	-6.8037	0.5977	129.5903	0.0001	
CLUSTER	AG	1	1.0872	1.2647	0.7390	0.3900	
CLUSTER	MDRY	1	-1.8586	1.3234	1.9723	0.1602	
CLUSTER	TRAN	1	2.6803	0.6340	17.8752	0.0001	
CLUSTER	WILD	1	1.0765	0.7629	1.9913	0.1582	
CLUSTER	YDRY	0	0.0000	0.0000	.	.	
REC_SITE	LGR	1	1.9605	0.0426	2116.2435	0.0001	
REC_SITE	LGS	1	0.9649	0.0455	449.6599	0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	.	
KM_T_LGR		1	0.0020	0.0006	11.4586	0.0007	
REL_MON	7	1	-1.4477	0.5672	6.5139	0.0107	
REL_MON	8	1	-0.2128	0.1497	2.0208	0.1552	
REL_MON	9	1	0.2424	0.0978	6.1449	0.0132	
REL_MON	10	1	0.2907	0.1296	5.0311	0.0249	
REL_MON	11	0	0.0000	0.0000	.	.	
LEN_AVGM		1	0.0215	0.0066	10.6547	0.0011	
M_FL_15		1	0.0010	0.0026	0.1382	0.7100	
AVGPREC		1	0.0894	0.0454	3.8861	0.0487	
KM_T_LGR*CLUSTER	AG	1	-0.0068	0.0016	18.7813	0.0001	
KM_T_LGR*CLUSTER	MDRY	1	0.0048	0.0030	2.6133	0.1060	
KM_T_LGR*CLUSTER	TRAN	1	-0.0029	0.0006	22.5259	0.0001	
KM_T_LGR*CLUSTER	WILD	1	-0.0016	0.0006	6.5573	0.0104	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
CLUSTER*REL_MON	AG	8	1	0.9911	0.7619	1.6925	0.1933
CLUSTER*REL_MON	AG	9	1	0.3038	0.7524	0.1630	0.6864
CLUSTER*REL_MON	AG	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	MDRY	8	1	0.2675	0.2617	1.0450	0.3067
CLUSTER*REL_MON	MDRY	9	1	-0.0736	0.2178	0.1142	0.7354
CLUSTER*REL_MON	MDRY	10	1	-0.1375	0.2295	0.3590	0.5491
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	TRAN	7	1	1.2660	0.7005	3.2664	0.0707
CLUSTER*REL_MON	TRAN	8	1	-0.0321	0.1794	0.0321	0.8579
CLUSTER*REL_MON	TRAN	9	1	-0.6450	0.1270	25.8002	0.0001
CLUSTER*REL_MON	TRAN	10	1	-0.5023	0.1498	11.2497	0.0008
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	WILD	7	1	1.6637	0.6657	6.2459	0.0124
CLUSTER*REL_MON	WILD	8	1	0.4254	0.3691	1.3283	0.2491
CLUSTER*REL_MON	WILD	9	1	-0.0231	0.3461	0.0045	0.9467
CLUSTER*REL_MON	WILD	10	1	-0.1312	0.3583	0.1340	0.7144
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000	.	.
LEN_AVGM*CLUSTER	AG	1	0.0125	0.0115	1.1701	0.2794	
LEN_AVGM*CLUSTER	MDRY	1	0.0057	0.0086	0.4417	0.5063	
LEN_AVGM*CLUSTER	TRAN	1	-0.0142	0.0069	4.2914	0.0383	
LEN_AVGM*CLUSTER	WILD	1	0.0022	0.0077	0.0791	0.7785	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
M_FL_15*CLUSTER	AG	1	-0.0079	0.0034	5.2660	0.0217	
M_FL_15*CLUSTER	MDRY	1	-0.0119	0.0039	9.1407	0.0025	
M_FL_15*CLUSTER	TRAN	1	-0.0070	0.0028	6.1555	0.0131	
M_FL_15*CLUSTER	WILD	1	-0.0126	0.0031	17.1196	0.0001	
M_FL_15*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
AVGPREC*CLUSTER	AG	1	-0.0573	0.0631	0.8250	0.3637	
AVGPREC*CLUSTER	MDRY	1	0.0937	0.0698	1.8021	0.1795	
AVGPREC*CLUSTER	TRAN	1	-0.0902	0.0541	2.7825	0.0953	
AVGPREC*CLUSTER	WILD	1	-0.0983	0.0519	3.5959	0.0579	
AVGPREC*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
SCALE		0	1.4704	0.0000	.	.	

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Model 4B

AVGPREC LGR Flow, and Interactions
After Outlier Deletions

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	ChiSquare	Pr>Chi	
INTERCEPT		1	-7.1998	0.5485	172.3040	0.0001	
CLUSTER	AG	1	0.9561	1.1308	0.7149	0.3978	
CLUSTER	MDRY	1	-1.4760	1.1625	1.6119	0.2042	
CLUSTER	TRAN	1	3.0864	0.5798	28.3333	0.0001	
CLUSTER	WILD	1	1.5322	0.6884	4.9546	0.0260	
CLUSTER	YDRY	0	0.0000	0.0000	.	.	
REC_SITE	LGR	1	2.0418	0.0396	2659.6529	0.0001	
REC_SITE	LGS	1	1.0310	0.0420	602.1071	0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	.	
KM_T_LGR		1	0.0012	0.0006	4.4909	0.0341	
REL_MON	7	1	-1.4388	0.5315	7.3299	0.0068	
REL_MON	8	1	-0.1549	0.1341	1.3325	0.2484	
REL_MON	9	1	0.0639	0.0896	0.5094	0.4754	
REL_MON	10	1	0.2512	0.1150	4.7695	0.0290	
REL_MON	11	0	0.0000	0.0000	.	.	
LEN_AVGM		1	0.0252	0.0061	17.2233	0.0001	
M_FL_15		1	0.0035	0.0025	1.9862	0.1587	
AVGPREC		1	-0.0520	0.0429	1.4671	0.2258	
KM_T_LGR*CLUSTER	AG	1	-0.0054	0.0014	14.4751	0.0001	
KM_T_LGR*CLUSTER	MDRY	1	0.0054	0.0026	4.4020	0.0359	
KM_T_LGR*CLUSTER	TRAN	1	-0.0020	0.0006	12.8192	0.0003	
KM_T_LGR*CLUSTER	WILD	1	-0.0009	0.0006	2.1023	0.1471	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
CLUSTER*REL_MON	AG	8	0.8907	0.6630	1.8046	0.1792	
CLUSTER*REL_MON	AG	9	0.3168	0.6550	0.2339	0.6286	
CLUSTER*REL_MON	AG	10	0	0.0000	0.0000	.	
CLUSTER*REL_MON	MDRY	8	0.2144	0.2296	0.8716	0.3505	
CLUSTER*REL_MON	MDRY	9	0.1020	0.1913	0.2840	0.5941	
CLUSTER*REL_MON	MDRY	10	1	-0.1002	0.2007	0.2491	0.6177
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000	.	
CLUSTER*REL_MON	TRAN	7	1	1.1305	0.6407	3.1141	0.0776
CLUSTER*REL_MON	TRAN	8	1	-0.2023	0.1607	1.5844	0.2081
CLUSTER*REL_MON	TRAN	9	1	-0.5080	0.1149	19.5647	0.0001
CLUSTER*REL_MON	TRAN	10	1	-0.5100	0.1330	14.6987	0.0001
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000	.	
CLUSTER*REL_MON	WILD	7	1	1.5924	0.6118	6.7753	0.0092
CLUSTER*REL_MON	WILD	8	1	0.2977	0.3226	0.8514	0.3561
CLUSTER*REL_MON	WILD	9	1	0.1000	0.3022	0.1095	0.7408
CLUSTER*REL_MON	WILD	10	1	-0.0979	0.3121	0.0983	0.7539
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000	.	
LEN_AVGM*CLUSTER	AG	1	0.0146	0.0105	1.9318	0.1646	
LEN_AVGM*CLUSTER	MDRY	1	0.0018	0.0078	0.0534	0.8172	
LEN_AVGM*CLUSTER	TRAN	1	-0.0179	0.0063	8.0201	0.0046	
LEN_AVGM*CLUSTER	WILD	1	-0.0039	0.0070	0.3047	0.5810	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
M_FL_15*CLUSTER	AG	1	-0.0119	0.0032	14.0520	0.0002	
M_FL_15*CLUSTER	MDRY	1	-0.0139	0.0036	15.1948	0.0001	
M_FL_15*CLUSTER	TRAN	1	-0.0109	0.0027	16.8117	0.0001	
M_FL_15*CLUSTER	WILD	1	-0.0136	0.0028	23.0585	0.0001	
M_FL_15*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
AVGPREC*CLUSTER	AG	1	0.1044	0.0587	3.1672	0.0751	
AVGPREC*CLUSTER	MDRY	1	0.2297	0.0629	13.3465	0.0003	
AVGPREC*CLUSTER	TRAN	1	0.0917	0.0505	3.3022	0.0692	
AVGPREC*CLUSTER	WILD	1	0.0386	0.0484	0.6373	0.4247	
AVGPREC*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
SCALE		0	1.2771	0.0000	.	.	

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Model 5A

AVGFLOW LGR Flow, and Interactions
Prior to outlier delete
Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	ChiSquare	Pr>Chi	
INTERCEPT		1	-7.1371	0.6382	125.0540	0.0001	
CLUSTER	AG	1	1.8401	1.2769	2.0767	0.1496	
CLUSTER	MDRY	1	-0.0947	1.2776	0.0055	0.9409	
CLUSTER	TRAN	1	2.8639	0.6653	18.5313	0.0001	
CLUSTER	WILD	1	1.3359	0.7836	2.9065	0.0882	
CLUSTER	YDRY	0	0.0000	0.0000	.	.	
REC_SITE	LGR	1	2.0019	0.0414	2343.6300	0.0001	
REC_SITE	LGS	1	0.9890	0.0443	498.8862	0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	.	
KM_T_LGR		1	-0.0001	0.0006	0.0187	0.8912	
REL_MON	7	1	-1.1495	0.5469	4.4170	0.0356	
REL_MON	8	1	-0.6073	0.1483	16.7699	0.0001	
REL_MON	9	1	-0.0593	0.1001	0.3515	0.5533	
REL_MON	10	1	0.2528	0.1254	4.0663	0.0437	
REL_MON	11	0	0.0000	0.0000	.	.	
LEN_AVGM		1	0.0142	0.0067	4.4357	0.0352	
M_FL_15		1	0.0195	0.0022	79.9848	0.0001	
AVGFLOW		1	-0.5054	0.0369	187.3777	0.0001	
KM_T_LGR*CLUSTER	AG	1	-0.0049	0.0015	10.2797	0.0013	
KM_T_LGR*CLUSTER	MDRY	1	0.0031	0.0026	1.4027	0.2363	
KM_T_LGR*CLUSTER	TRAN	1	-0.0008	0.0006	1.4455	0.2292	
KM_T_LGR*CLUSTER	WILD	1	0.0005	0.0007	0.5110	0.4747	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
CLUSTER*REL_MON	AG	8	1.3556	0.7388	3.3667	0.0665	
CLUSTER*REL_MON	AG	9	1	0.7008	0.7293	0.9235	0.3366
CLUSTER*REL_MON	AG	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	MDRY	8	1	0.8271	0.2476	11.1634	0.0008
CLUSTER*REL_MON	MDRY	9	1	0.1980	0.2145	0.8523	0.3559
CLUSTER*REL_MON	MDRY	10	1	-0.0942	0.2227	0.1789	0.6723
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	TRAN	7	1	1.3237	0.6735	3.8627	0.0494
CLUSTER*REL_MON	TRAN	8	1	0.3813	0.1740	4.8028	0.0284
CLUSTER*REL_MON	TRAN	9	1	-0.3070	0.1241	6.1199	0.0134
CLUSTER*REL_MON	TRAN	10	1	-0.3982	0.1452	7.5187	0.0061
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	WILD	7	1	1.3628	0.6431	4.4913	0.0341
CLUSTER*REL_MON	WILD	8	1	0.8042	0.3592	5.0122	0.0252
CLUSTER*REL_MON	WILD	9	1	0.2644	0.3377	0.6129	0.4337
CLUSTER*REL_MON	WILD	10	1	-0.0971	0.3480	0.0778	0.7803
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000	.	.
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000	.	.
LEN_AVGM*CLUSTER	AG	1	0.0122	0.0122	1.0004	0.3172	
LEN_AVGM*CLUSTER	MDRY	1	0.0094	0.0087	1.1595	0.2816	
LEN_AVGM*CLUSTER	TRAN	1	-0.0062	0.0070	0.7812	0.3768	
LEN_AVGM*CLUSTER	WILD	1	0.0115	0.0078	2.1692	0.1408	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
M_FL_15*CLUSTER	AG	1	-0.0243	0.0031	61.6097	0.0001	
M_FL_15*CLUSTER	MDRY	1	-0.0265	0.0033	62.8239	0.0001	
M_FL_15*CLUSTER	TRAN	1	-0.0255	0.0024	115.8668	0.0001	
M_FL_15*CLUSTER	WILD	1	-0.0323	0.0026	159.4678	0.0001	
M_FL_15*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
AVGFLOW*CLUSTER	AG	1	0.4396	0.0620	50.3480	0.0001	
AVGFLOW*CLUSTER	MDRY	1	0.4193	0.0555	57.1128	0.0001	
AVGFLOW*CLUSTER	TRAN	1	0.3917	0.0434	81.5419	0.0001	
AVGFLOW*CLUSTER	WILD	1	0.4715	0.0430	120.2724	0.0001	
AVGFLOW*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
SCALE		0	1.4287	0.0000	.	.	

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Model 5B

AVGFLOW LGR Flow, and Interactions After Outlier Deletions

Analysis Of Parameter Estimates

Parameter		DF	Estimate	Std Err	ChiSquare	Pr>Chi	
INTERCEPT		1	-7.1426	0.5774	153.0316	0.0001	
CLUSTER	AG	1	1.6096	1.1575	1.9339	0.1643	
CLUSTER	MDRY	1	-0.1408	1.1427	0.0152	0.9019	
CLUSTER	TRAN	1	2.8414	0.6022	22.2640	0.0001	
CLUSTER	WILD	1	1.4086	0.7072	3.9673	0.0464	
CLUSTER	YDRY	0	0.0000	0.0000	.	.	
REC_SITE	LGR	1	2.0664	0.0388	2841.1686	0.0001	
REC_SITE	LGS	1	1.0469	0.0413	642.0905	0.0001	
REC_SITE	MCN	0	0.0000	0.0000	.	.	
KM_T_LGR		1	0.0003	0.0006	0.2742	0.6005	
REL_MON	7	1	-1.0751	0.4878	4.8581	0.0275	
REL_MON	8	1	-0.4908	0.1348	13.2541	0.0003	
REL_MON	9	1	-0.0470	0.0914	0.2642	0.6072	
REL_MON	10	1	0.2599	0.1145	5.1548	0.0232	
REL_MON	11	0	0.0000	0.0000	.	.	
LEN_AVGM		1	0.0134	0.0061	4.8121	0.0283	
M_FL_15		1	0.0171	0.0020	72.9549	0.0001	
AVGFLOW		1	-0.5289	0.0330	256.2703	0.0001	
KM_T_LGR*CLUSTER	AG	1	-0.0048	0.0014	11.8377	0.0006	
KM_T_LGR*CLUSTER	MDRY	1	0.0027	0.0024	1.2792	0.2581	
KM_T_LGR*CLUSTER	TRAN	1	-0.0012	0.0006	3.9895	0.0458	
KM_T_LGR*CLUSTER	WILD	1	-0.0000	0.0006	0.0005	0.9822	
KM_T_LGR*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
CLUSTER*REL_MON	AG	8	1.2520	0.6594	3.6044	0.0576	
CLUSTER*REL_MON	AG	9	0.6668	0.6508	1.0496	0.3056	
CLUSTER*REL_MON	AG	10	0	0.0000	0.0000	.	
CLUSTER*REL_MON	MDRY	8	0.7113	0.2222	10.2426	0.0014	
CLUSTER*REL_MON	MDRY	9	0.1847	0.1922	0.9240	0.3364	
CLUSTER*REL_MON	MDRY	10	1	-0.1027	0.2000	0.2638	0.6075
CLUSTER*REL_MON	MDRY	11	0	0.0000	0.0000	.	
CLUSTER*REL_MON	TRAN	7	1	1.2447	0.6008	4.2927	0.0383
CLUSTER*REL_MON	TRAN	8	1	0.1797	0.1586	1.2846	0.2570
CLUSTER*REL_MON	TRAN	9	1	-0.2995	0.1128	7.0541	0.0079
CLUSTER*REL_MON	TRAN	10	1	-0.4512	0.1327	11.5665	0.0007
CLUSTER*REL_MON	TRAN	11	0	0.0000	0.0000	.	
CLUSTER*REL_MON	WILD	7	1	1.2292	0.5736	4.5927	0.0321
CLUSTER*REL_MON	WILD	8	1	0.6135	0.3215	3.6414	0.0564
CLUSTER*REL_MON	WILD	9	1	0.1917	0.3018	0.4035	0.5253
CLUSTER*REL_MON	WILD	10	1	-0.1116	0.3111	0.1287	0.7198
CLUSTER*REL_MON	WILD	11	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	7	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	8	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	9	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	10	0	0.0000	0.0000	.	
CLUSTER*REL_MON	YDRY	11	0	0.0000	0.0000	.	
LEN_AVGM*CLUSTER	AG	1	0.0133	0.0111	1.4239	0.2328	
LEN_AVGM*CLUSTER	MDRY	1	0.0102	0.0078	1.6851	0.1942	
LEN_AVGM*CLUSTER	TRAN	1	-0.0056	0.0063	0.7765	0.3782	
LEN_AVGM*CLUSTER	WILD	1	0.0110	0.0071	2.4031	0.1211	
LEN_AVGM*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
M_FL_15*CLUSTER	AG	1	-0.0222	0.0028	61.7859	0.0001	
M_FL_15*CLUSTER	MDRY	1	-0.0238	0.0030	61.5275	0.0001	
M_FL_15*CLUSTER	TRAN	1	-0.0235	0.0022	116.4033	0.0001	
M_FL_15*CLUSTER	WILD	1	-0.0290	0.0023	154.2537	0.0001	
M_FL_15*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
AVGFLOW*CLUSTER	AG	1	0.4088	0.0570	51.3905	0.0001	
AVGFLOW*CLUSTER	MDRY	1	0.4458	0.0498	80.0505	0.0001	
AVGFLOW*CLUSTER	TRAN	1	0.4243	0.0391	118.0451	0.0001	
AVGFLOW*CLUSTER	WILD	1	0.4829	0.0385	157.1019	0.0001	
AVGFLOW*CLUSTER	YDRY	0	0.0000	0.0000	.	.	
SCALE		0	1.2733	0.0000	.	.	